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AN EXAMINATION

OF

SILVER'S

MARINE GOVERNOR:

WITH

REMARKS ON GOVERNORS

IN GENERAL.

BY REYNELL COATES, M. D.,

Literary and Scientific Redactor, &c.

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American Marine Governor Manufacturing Company.

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Application has been made to the undersigned, as a professional writer and critic, by parties interested in Silver's Marine Governor, for a candid review of its character and merits as a safeguard to property and life. This may appear a work of supererogation to those who are familiar with the high encomiums already bestowed upon it by philosophers and practical men on both sides of the Atlantic, but, as the request is made by those best able to judge of its propriety, the commentator proceeds to the task with the pleasure always attendant upon the rendition of just praise to real merit.

Silver's Marine Governor.

In order to place this recent and highly important invention properly before the public, it is necessary to take a hasty preliminary view of the purpose to be answered by governors in machinery, the common principle upon which the most successful contrivances of this nature previously in use have been constructed, the defective application of this principle under all circumstances, and the almost total inapplicability of these instruments to marine necessities. We will then proceed to examine to what extent the pre-existing deficiencies have been remedied by Mr. Silver.

In all machines designed for the application of great force, whatever be the motive power, it is requisite that the amount of this power should be proportional to the amount of labor to be performed or resistance to be overcome in a given time. If the amount of motive power be too slight when compared with the resistance, there results either a loss of economy in time or an utter inability to accomplish the work at all. If it be too great, the motion of the machine becomes too rapid for regular action, and when the excess of speed reaches a certain point, some part of the apparatus must necessarily give way.

Again; in a heavy machine, if the resistance be greatly and suddenly increased while it is in full operation, something is almost sure to be broken; and if it be as suddenly diminished while the motive force continues to act with the same energy, the velocity is rapidly and dangerously accelerated, the machine is said to "race," or to "run away from the engineer," and, even the ordinary resistance being re-applied under such circumstances, the destruction of the apparatus or some portion of it becomes extremely probable.

But there are very few machines of much power, of which the parts act constantly at the same mechanical advantage; nor are there many in which the kind and amount of labor to be performed are at all times the same. In numerous cases, the same engine is required to drive a variety of dissimilar apparatus; some parts demanding great force, and some, comparatively little. These are coupled and uncoupled suddenly, according to the exigencies of the various operations, and thus the amount of resistance is subjected to violent changes, which, if no counteracting arrangement were made, would render the machine either liable to dangerous shocks, or incapable of continuing its proper labors. In marine engines, the changes of resistance are scarcely less severe than in those employed on land, and they are far less subject to human control; being the result of elementary action; such as the rolling and pitching of a steamer, by which the paddles or propeller are alternately elevated above or plunged below the surface; the blows of waves; the shipping of seas, &c.

The only mode of protecting a machine against all severe and sudden jars, to which it must inevitably be subjected in the performance of its legitimate duties, is to apportion its strength to the maximum energy of the motive force designed to bear upon it; and this is a question of original construction, the strength and stress of material: but the mode of avoiding the evils resulting from racing, or the undue retardation of motion and the consequent waste of momentum and time, is a different problem.

In stationary engines, the milder changes of resistance, and, to a certain extent, even the more severe, are often more or less compensated by the contrivance known as the momentum wheel, which, by its weight, acts as a reservoir of force, opposing all sudden changes of velocity: but even this partial remedy cannot be conveniently applied at sea, where saving of space and the absence of unnecessary weight are of the utmost importance. The only available means for effecting the closest possible approximation to that uniformity of velocity in machinery which is so essential alike to economy and safety, consists in so regulating the motive-power that it shall vary, within all proper limits, *inversely as the velocity*; so as to establish an average adapted to the work in hand, whatever may be the amount of resistance for the moment. Thus; the least proper amount of speed for the time being, and, also, the greatest amount of speed consistent with safety and economy being determined; the mean between these rates is desirable as a permanency. When any cause produces an acceleration of motion beyond this point, the motive force should be diminished gradually until the maximum of safe speed is reached; when it should cease entirely, until, by the loss of momentum, the velocity is reduced to the standard. On the contrary, when any cause unduly retards the motion, the motive-power should gradually increase, until its maximum of energy is reached at the moment when the speed becomes a minimum. If this end could be perfectly accomplished, all "racing" would be rendered impossible.

In the management of water-power, the necessary regulation is best accomplished by the flood-gate; in steam-power machinery, by the throttle valve; either of which may be controlled by human force, or by self-regulating mechanical arrangements. Our present subject may be more readily illustrated by confining our attention to the steam-engine, and we shall do so accordingly.

The throttle valve of an engine, when entirely closed, cuts off the motive force, by arresting the flow of steam to the cylinder, and when entirely open, raises that force to its maximum under the then existing pressure. Between these extremes, or when partially closed, it offers an obstacle to the free passage of the steam, and proportionally diminishes the pressure on the piston. In the early rise of the steam-engine, this valve was exclusively worked by the hand of the engineer, and, until very recently, no satisfactory mechanical substitute for this direct application of human agency in preventing accidents from suddenly varying resistance in marine machinery has been

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discovered. Mr. Watt, however, succeeded in accomplishing this very desirable object in stationary engines, by the invention of the ordinary Governor.

His highly ingenious contrivance essentially consists of a perpendicular spindle or axis, having suspended upon it, at or near the summit, two opposite lateral and freely pendant arms, with hinge-like attachments, permitting them to approach or recede from the axis when acted upon by any moderate force. Each of these arms is loaded, at or near its lower extremity, with a heavy metallic ball, and is connected, near the middle, with a rod, descending obliquely, to be attached to the corresponding side of a sliding sleeve. This sleeve works freely along the perpendicular spindle or shaft, and all the attachments of the rods have hinge-like motion:—it is also connected, by any convenient arrangement, with one end of a lever, the other end of which operates upon the throttle valve; opening it as the sleeve descends, and closing it as the sleeve ascends. The spindle is furnished with a geer or cog-wheel connecting it with the engine, by means of which it is made to revolve, when the machine is in motion. When in action, the revolution of the heavy balls and pendant arms calls into play their centrifugal force; and when this becomes sufficient to overcome their gravity, they separate to an extent proportionate to the velocity of the engine; thus raising the sliding sleeve, and contracting the orifice of the throttle valve; after which, on any decline of speed, the balls and arms subside, and produce an exactly opposite effect upon the valve. Thus it will be perceived that, so long as the velocity of the apparatus is insufficient to overcome the gravity of the balls and arms, the throttle valve remains fully open, and the motive-power acts with its full energy; but, the moment that an undue pressure of steam in the boiler, or an accidental or intended diminution of the usual resistance occurs, the Governor checks the excess, or if this undue pressure or removal of resistance be excessive and dangerous, it cuts off the motive-power completely, and perfectly protects the engine from injuries from that source.

This ordinary Governor has been of incalculable advantage in the regulation of machinery, but it labors under three important disadvantages:—

First; Its action is regulated by the equality between the centrifugal force of the balls, on the one hand, and their gravitating force, upon the other. But as the force of gravity in any given place is

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invariable in energy, the delicacy or susceptibility of this Governor can only be varied either by varying the weight of the balls or by changing their position on the arms; neither of which can be accomplished without some considerable trouble and loss of time. The *Second* disadvantage is of far more importance, and demands fuller comment; it is as follows:—

The centre of gravity of the balls of the ordinary Governor being below the point of suspension, and their gravity being the sole agent in *opening* the throttle valve, any considerable obliquity of the spindle or shaft must cause the weight of one ball, at each instant except when both are nearly in the same horizontal plain, to oppose that of the other; the one tending to close the valve while the other tends to open it:—thus, the power of increasing the speed of the engine, or, in other words, the power of opening the valve, will depend upon the difference, instead of the sum of the effective gravitation of the balls; and any increase of the obliquity must continually diminish the effective power of gravity over both balls, viewed as a system.

It is obvious that, from these causes, the forces which tend to open the valve must become less and less efficient with increasing obliquity of the spindle, until, when this becomes horizontal, they cease to act at all; the gravity of one ball, in that position, exactly counteracting that of the other. Meanwhile, the centrifugal force of the balls, under any given velocity, continues the same in all attitudes; and hence, in proportion to the obliquity, the effective energy of the engine must be gradually enfeebled, until, when the spindle is nearly in the horizontal attitude, the instrument becomes useless as a regulator; the valve remaining constantly closed even at very low velocities. This latter objection must necessarily condemn the ordinary Governor for marine purposes or on the great lakes; it must also seriously lessen its value in river navigation, and even diminishes its convenience in stationary engines. The difficulty, morever, springs from the inherent nature of one of the forces employed, and appears incapable of remedy.

Equally irremediable is the third objection, nor is it less dependent upon the action of gravity. It results from the inertia of the balls. Whenever the Governor either rises or falls with the motion of the machinery to which it is attached, the inertia of the balls tends to keep these balls in the precise horizontal plane of revolution in which they happen to be at the moment when the change of position occurs.

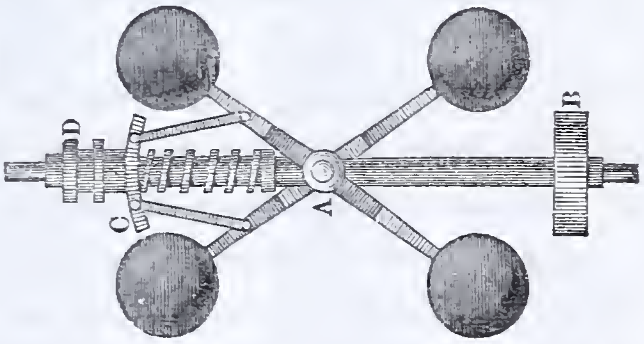
That is; when the Governor *descends*, the effect of gravity is opposed by the inertia, and both balls tend to separate to a greater extent with the same centrifugal force; thus *diminishing*, at the instant, the supply of steam under the same velocity of the machine: and, when the Governor *ascends*, the inertia acts in the same direction with gravity, *increasing* the supply, under the same velocity. Hence must result a series of jerkings and irregularities, which, though not very intense or long continued, become very highly important by constant repetition. The ordinary Governor can not be so modified as to lessen this evil; and, when it is remembered that a vessel at sea reproduces such an irregularity at every rise or pitch, and at every roll, the loss, even in the fairest weather, may be duly appreciated.

Several attempts have been made to modify the ordinary Governor, while still employing gravity as one of the regulating forces. Of these, the only contrivance demanding a passing notice is that of Mr. Brunel, Engineer in Chief to the British Government. This engineer proposed to duplicate the armature of the apparatus. A second pair of arms was attached by hinges to the sliding sleeve, from which they passed upwards, crossing the dependent arms at the middle of their length, where they were connected by pivot, each with its corresponding arm, so as to form a lozenge with moveable joints at the angles, having the upper sides extended downwards to the usual distance, and the lower sides extended upwards, to about the level of the point of suspension. Each of the four extensions was armed with its proper ball or weight; so that the centrifugal force was produced by four balls, instead of two, only. This arrangement had the effect of bringing the centre of gravity of the system of balls about one-half nearer the centre of suspension; and by elongating the ascending arms, these points might be approximated to any desired extent; but this capacity in no degree removed the difficulty of adapting it to marine engines, or fitted it for action in oblique positions. Moreover, as the gravity of the two upper balls opposed that of the two lower, in their action on the sleeve, the actual effect of gravity in opening the valve by means of such a Governor was regulated by the *difference* in weight between the former and the latter pair, while their centrifugal force, while in motion, tended to close the valve with an energy proportionate to the *sum* of their weights. The delicacy of this instrument in *arresting* the motion of stationary machinery may be carried to any degree of refinement, but only at the expense of its capacity to *increase* the motive force, when such increase becomes desirable. There may be possible mechanical operations, in which this irregularity of action would be useful, but none such are familiar to us;—certainly, there are none in the ordinary applications of the steam-engine.*

Certain hydraulic or pneumatic contrivances have been invented as substitutes for the mechanical Governor, in the regulation of steam-machinery at sea, but we have seen none of these that demand, by their simplicity and certainly of action, especial reference here.

The great merit and chief originality of Mr. Silver's Governor consists in the fact that it altogether discards the action of gravity in opposing the centrifugal force; substituting therefor a spiral spring so arranged that its power, and consequently the delicacy of the instrument, may be varied at any moment, and that, under most circumstances, without uncoupling it or arresting the motion of the engine.

This apparatus may be clearly understood; even by persons not very familiar with machinery, by the aid of a single cut, representing its simplest form, which, however, is susceptible of many changes, by varying the position, &c., of its elementary parts. It consists essentially of an axis or spindle, near the middle of which, at A, (*See Figure*) two moveable arms, bearing balls of equal weight at each extremity, are attached by pivot. Near one end of this axis is attached a fixed pully, or similar contrivance, which, being connected, by belt or otherwise, with the machinery, gives rotation to the spindle, and centrifugal force to the balls. Near the other end of the axis is a sliding sleeve, C, upon which is seen a collar, D, intended to receive one



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* It is but justice to Mr. Brunel to state that, since this essay was commenced, he has had the opportunity of comparing the action of his apparatus with that of Mr. Silver, and that, on due examination, he immediately displayed the magnanimity of the genuine philosopher, by yielding the palm to the latter, and certifying his conviction in the most manly manner, by causing his Governors to be removed from the engines of the celebrated "Leviathin," now upon the ways, in England, and that of Mr. Silver substituted therefor.

end of the bent lever or system of levers connecting the Governor in with the throttle valve, and which need not be represented, to any one who has seen an ordinary Governor in action. The sliding sleeve is connected with the revolving arms by means of two rods or bars with free pivot motion at either end, and the sleeve, with its attached bent lever is thus compelled to follow the motions of the four balls, as these advance towards, or recede from the axis. The centrifugal force of the balls is resisted by a spiral spring, encircling the spindle, fixed at the end next the centre of action of the arms, and attached to the moveable sleeve at the other. This spring may be so arranged as to resist the separation of the balls either by extension or compression. The latter is the mode of arrangement represented in the figure. There are various ways in which the force of this spring, and consequently, the delicacy of the Governor, may be brought under the immediate control of the engineer. One well adapted to the form represented, is, by employing an adjustable collar for the end of the spring next the centre of action of the arms, capable of being fixed at any desired distance therefrom by a set screw.

It will be perceived that the four balls of this Governor being of equal weight, and equi-distant from the centre of support on the axis of motion at B, the centre of gravity of the whole system corresponds with the centre of suspension; and if the spring and the bent lever were removed, the balls, when not in action, would remain at rest in any possible attitude. This places the effect of the apparatus when in use, absolutely beyond the influence of gravity or change of position. No rolling or pitching of a vessel, however sudden, no jar from the crest of a wave, can exercise the least influence over its action as long as it preserves its own integrity. So soon as the friction of the pivots, sleeves and throttle valve are overcome by the centrifugal force, its power of regulation would commence, were it not for the opposition of the spiral spring, which, being increased or diminished in tension at will, may be adapted to any desirable range of speed, with the utmost facility. For these reasons, its perfect adaptation to the wants of the steam marine must be patent to every examiner who knows any thing whatever of the principles of mechanics, and is free from that peculiar blindness, but too common among practical and interested men, which refuses to investigate any novelty whatever.

The advantages of this Governor are so obvious, that it has met with nearly universal and enthusiastic praise; but, as one distinguished engineer has expressed the opinion, that no mechanical contrivance can properly supply the place of the human hand in regulating the speed of a marine engine by means of the throttle-valve, it becomes necessary, before attempting to disprove his position, to consider what are the chief irregularities of resistance which oppose the equable motion of a steamer at sea.

The resistance of the water to paddle or propeller, submerged to a given extent, and moving with a given velocity, is not proportionate to its actual, but to its relative rapidity, as compared with that of the water: thus, it is far greater when a vessel is moving with a current, than when she is opposing it. Except from the action of winds or currents, or the re-action of inclined planes on shoals or coasts, the sea-wave or roller gives to the water no forward motion—the particles which form it are merely rising and falling perpendicularly, in an alternate, pendulum-like order; the *form* but not the *substance* moving onward. The effect of current, whether on wave or roller, is not a sudden, but a regular one. In high winds at sea, or from the re-action of the bottom on coasts, the crest of a wave or roller is often urged forward with great force, and is capable of striking blows which may shatter rocks, or make the stoutest vessel reel, if received too directly. Such blows, under the bows, violently retard or arrest the advance of the ship, and consequently increase the resistance of the water to the motion of paddle wheels or propellers; or, if the blows occur under the stern, they as suddenly urge her onward, and diminish the resistance. The effects of steady currents do not require the compensating action of the Governor, and those of the sudden blows do not admit of it, as they can neither be foreseen with any certainty by a man at the throttle-valve, nor made to act upon the Governor till a blow has been actually received. The only securities against the dangerous excesses of such sudden impulses, are found in a cautious reduction of speed when damage is anticipated, and in a skillful management of the helm, so as to enable the ship to receive and yield to the force of a coming billow, in a favorable direction.

Again; in traversing or being followed by heavy and long billows, a vessel struggles up the ascent, and hurries down the descent, under the action of gravity, like a deer coursing a rolling prairie.—The vessel, in descending thus, buries herself deeper when she

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reaches the trough of the sea. In all these ways her velocity is alternately checked and accelerated; but, from the last mentioned cause, the retardation much exceeds the acceleration. By its action in equalizing the velocity, the Marine Governor reduces this effect to a minimum; shortening the voyage and very materially economizing fuel. In relation to this cause of inequality, the paddle wheel labors under greater disadvantage than the propeller; because the former, applying its driving power above the centre of bouyancy of the vessel, buries the bow deeper in the trough, and the latter, acting below that point, eases the rise of the wave.

All these causes of varying resistance, however, sink into matters of very secondary consideration, so far as the strain upon the engine is concerned, when compared with others resulting from the position of the wheels or propellers under different circumstances. In paddle steamers, when the vessel happens to be crossing the trough of a short sea, with her bow elevated upon the rise of one billow and her stern on that of another, her paddles are elevated, more or less completely, from the water, and an instantaneous racing commences, to the great and unnecessary exhaustion of steam; and, if this effect be considerable, the condenser becomes incapable of acting properly from the great rapidity of the injections. The re-entering of the paddles when moving with this excessive velocity is productive, moreover, of a violent shock, very dangerous to the machinery.

Difficulty of precisely the same nature occurs with the propeller, when the vessel is riding the summit of a wave, and commencing the descent. The propeller is then lifted, it may be, entirely out of the water, and, all resistance but that of the air being removed, racing commences at the instant, and continues until the propeller is again submerged; when the shock of the blow of the blades upon the water may be tremendous. In fact, the only advantage which the propeller enjoys over paddle-wheels under such circumstances is, that it escapes the additional evils resulting from the rolling of the vessel; being influenced solely by the pitching; and even this is nearly compensated by the comparatively slight effect which heavy pitching produces upon paddle-wheels.

Most of the dangers of which we have just been speaking are greater with a following sea, because the velocity of a vessel with a head sea diminishes the time occupied in passing from trough to trough, or from crest to crest of the billows; thus lessening both the

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accelerating and the retarding influence of the gravity of the vessel, and also, shortening the intervals during which the propeller or paddles are held more or less completely above the surface, so as to induce racing. The only dangers properly intervolved with our subject that are greater in a head sea than in sailing before the wind, are that which results from the increase, in the former case, of the force of the blows of waves under the bows, and the shipping of seas; but these are overbalanced by the terrible, though rare accident of being boarded abaft by a sea in scudding.

But the system of waves which a vessel is compelled to confront is rarely a simple one; cross seas, or sea-upon-sea being the rule, and simple rollers the exception. Moreover, the course of a vessel is very seldom either directly opposed to, or correspondent with that of the principal waves. Usually, it is oblique; and occasionally, by accident or necessity, the ship lies parallel with the billows, or, as it is termed, in the trough. In the last two cases, the dangers of marine steamers result chiefly from the rolling of the ship; and these, as has been stated, are far greatest with side-wheel steamers. In rolling, each side-wheel of a steamer is alternately submerged to an unusual depth, or lifted nearly or entirely out of water, while its fellow is in the opposite condition. The resistance of the water against the submerged wheel is then greatly increased, though, it is far from being duplicated; while that against the emerged wheel is almost or entirely removed. This cause may be productive of either of two accidents, both highly important; one of them peculiarly fatal, and neither, by any means uncommon: we allude to the destruction of the paddles by the sudden force of the blow on still water, when they first strike with accumulated velocity after being elevated; and the breaking of the shaft by the twisting resulting from the unequal resistance against the two wheels, rendering the steamer, as such, almost unmanageable.

It would be supererogatory to expend words in explaining how essentially an efficient Governor must counteract all the formidable evils which have been enumerated, except the sudden blows of a head sea. Without such an aid, in times of difficulty, there is no resource but to lessen the general rate of speed in a degree proportionate to the danger, at great sacrifice of time: and even this is impossible in scudding; because high speed, in that operation, is essential to safety. There can be no doubt that, with a suitable

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Governor, an average speed far exceeding that which would be risked without it, can be maintained with ease and propriety. Had the ill-fated Central America been thus provided, it is at least probable that some hundreds of human beings whose remains lie bedded among the sea-shells, many a fathom deep, would now be enjoying themselves by the domestic fire-side.

With the exception of a single instance, the replies of all engineers and marine officers who have examined Mr. Silver's Governor, or who, like Captain West, of the Atlantic, and Captain Bell, of the Belgian Royal Mail steamer, have employed it on their vessels, are uniformly enthusiastic in its praise; and the objections in this single instance are not directed against this Governor in particular, but, against all Governors for marine engines. In a spirit of fairness, we state this exceptional case in the words of the objector.

"I consider Mr. Silver's (the Marine Governor,) with Mr. Horatio Allen's improvement, as having the preference over all others that have come under my notice, for the reason that its action is not affected by any change of position in which it may be placed by the motion of the vessel.

"I am, however, of opinion that it is not so advantageous as having experienced men to attend to the throttle-valves, and I have found that men who are accustomed to the various noises and movements of a steam engine in cases for which this machine is intended to act, can govern the throttles so as to check undue racing or stacking, by closing and opening them in advance of those irregular motions, while this machine does not act until a difference of velocity of the engine is created."

The only other objections raised by this engineer, and not analyzed in our preceding remarks, are contained in the following sentence:—

"The addition of this Governor will add a somewhat complicated machine that will occasion inconvenience in attaching to marine engines where preparations have not been made in the original design; it will occupy additional space, and does not add to the power, or economy of fuel."

The grand objection, that Silver's Governor does not, or rather, that no Governor can foresee the proper moment of action, while the human intellect enjoys this capacity, appears to us more specious than real. There can be no change in "the various noises and movements" of an engine, except such as result from a change of action;

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and therefore, no such noises or movements can antidate the change, so as to warn an engineer shut up in his room of coming events outside. It is indeed true, that changes in the position of the vessel produce changes in the bearings of the machinery under the action of gravity; and hence arise alterations of friction, &c., which may be recognizable by a delicate and practiced eye, ear or touch; and if waves of the sea were as regular and uniform as the strokes of a piston, these results might speak a language prophetic of the future; but that they can be thus useful in the midst of the incalculable variations of surface, and the interminable jars produced in a sea voyage, especially during a storm, is what our experience of the sea compels us to doubt. That racing might *sometimes* be prevented by such human foresight is probable, but that it should be *regularly* so prevented appears impossible to us, and we cannot avoid the impression that a great majority of thorough sailors will agree with us in this. Besides, it is a positive *evil* that the operator should check the threatened increase of velocity "in advance;" for, by so doing, he must retard the voyage, and cause an unnecessary expenditure of fuel, however slight it may be. In a short, high sea—especially a head sea—the necessity for the regulation of the valve occurs in the crossing of every billow or trough, and the sum of such anticipations in a long voyage, would amount to a very serious loss of time. In fact, no man at the throttle-valve *ever attempts to notice the constantly recurring minor instances of racing*, by which more steam and fuel are lost in ordinary voyages, during mild weather, than in storms!

It is not an occasional prevention, but a mechanically certain and speedy *arrest* of incipient racing, that is necessary to the safety of person and property at sea, and to economy and profit in marine affairs. For this purpose, well regulated machinery, if adapted to the end in view, is, in its very nature, vastly more certain than human judgment and skill, under all the requirements of sleep, exhaustion, mood, temper, &c., with the additional dangers occurring on shipboard, where "the Admiral" is so liable to being "tapped," in spite of the precautions of the officers! If human skill were indeed better than machinery for this purpose, the argument would be equally applicable to presses, mills, &c., by land, and all governors should be discarded on shore as well as at sea; for, the anticipation of shocks would prove more important in a rolling mill or great printing

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establishment, than in a marine engine; but the general experience of mankind runneth to the contrary.

As to the difficulty of attaching the apparatus without change of plan, where boats are already completed or being built, this is a matter to be determined by the circumstances in each case; but that the adaptation would be generally difficult, is hardly to be believed. It was not found to be so by Mr. Brunel, in the case of the Leviathan. At last; this is a question of pence against life and certain ulterior profit, which experience has so far resolved most favorably. The plea of complexity may safely be left for answer to the machine itself, speaking by its beautiful simplicity; and, as to the objection of the space required—a point of real importance, especially in vessels of war—its amount is so very trifling, and the apparatus is so capable of being bestowed wherever convenience dictates, even at a very long distance from the valve, that it is hard to conceive embarrassment on this account; especially as the very nature of a steam engine necessarily leaves many little nooks unoccupied.

The Governor was never intended *to add* to what is technically termed "the power" of an engine, but so *to regulate* that power as to greatly enhance its *effect;* and no mechanic will deny that anything which lessens the expenditure of steam for no useful purpose, while giving additional security to the paddles of side-wheels, the blades of propellers, and the shafts of both, must not only diminish the daily expense of fuel, but, by shortening the entire duration of a voyage, its total expense also.

As the author of these objections speaks approvingly of the invention of Mr. Horatio Allen, which he styles an improvement on Silver's Governor, it is proper to name it in this connection, though really forming no part of the Governor at all. It consists of a little cylinder, with a piston and curiously arranged valves, the whole placed in immediate connection with the lever of the throttle-valve, and under command of the Governor; the object being to allow of a certain range of variation in the speed of the engine without interference on the part of the latter, and to render that interference more prompt and instantly effective in totally arresting or renewing the action of the motive-power, accordingly as the velocity exceeds or falls short of the admitted range. This is an entirely independent piece of machinery placed as an intermediate agent between the Governor and the throttle; it is therefore unnecessary to analyse its

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structure and applications in this article; and we pass it with a deserved compliment to the mechanical ingenuity displayed in its contrivance, and the simple remark that it seems to us to interfere with the slight, but very numerous *small savings* which the Governor acting immediately on the valve might effect in mild weather. The value of the unaided instrument for this purpose may be estimated from the fact, that it acts *very* effectively on the valve in less than the time occupied by half a revolution of the wheel. Mr. Allen's machine, however, is associated with Mr. Silver's instrument on the Steamers Atlantic, Baltic, Adriatic and Constitution.

The scarcely measureable advantages derivable from the use of a suitable Governor for Marine engines, must be obvious to every intelligent mind; and those who have carefully considered the foregoing strictures will probably grant that the world owes to Mr. Silver the first unexceptionable instrument of this character. We understand that a Commission has been established by the French Government to test it practically, with a view to its introduction throughout the entire French Steam Marine, if successful; and of this there can be no doubt; for American experience has brought the question of its success to a foregone conclusion; as the contents of the Appendix and, especially, the certificates of the Officers of the Atlantic will amply testify. The encomiums passed upon the instrument at recent meetings of the British Association have been highly enthusiastic, and the Appendix will furnish such evidence of its great value as should recommend it most strongly to the American Government, as well as the mercantile service. Any one who has carefully examined the history of those terrible founderings of steamers within the last few years, of which the very memory causes the heart to ache and the limbs to shudder, will perceive, we think, that much of the loss of life and property therein recorded would have been saved by the earlier invention and introduction of this admirable instrument.

If we have said but little of the application of Silver's Governor to machinery by land, it is because examples of its use for such purposes are far more readily accessible to all. If any one be desirous of witnessing the neatness, compactness and exquisite delicacy of action which it displays, let him examine it, as now in use at the United States Mint, or descend into the basement of the Ledger Buildings in Philadelphia, where it will be seen varying at almost every second, under the thousand momentary changes of resistence in the machinery of those large and complicated establishments. The little economies in the expenditure of steam alone, from the extreme watchfulness and promptitude of this Governor, must amount, in a month, to a very considerable sum. In New England, Governors are employed upon locomotives; here, we believe, they are not; but any one, who has witnessed the short, quick pantings of the iron horse when wasting its energies over a greased or icy rail, must agree with us in thinking that the proverbial shrewdness and economy of the North are favorably displayed in the adoption of such regulation for railroad engines. For such a purpose, the advantages of Silver's Governor are incalculable, from its independence of shocks, oscillations, or tremulous agitation, and its capacity for action in every attitude.

In the foregoing pages, we have given, as we always do when investigating a philosophical question or a mechanical contrivance, a candid and unreserved opinion of the practical value of Silver's Governor; but, in this case, we enjoy the rare satisfaction of truthfully bestowing unmitigated praise.

REYNELL COATES.

Address; Box 1074 *Philada. P. O.*

CAMDEN, NEW JERSEY,
January, 1858.

APPENDIX.

REMARKS, OPINIONS, CERTIFICATES, &c.

Rapidity of Racing.

In the event of short or cross seas, it is impossible for human foresight to meet the case, even under half pressure of steam: in spite of the most careful attention of the engineer, the engine will sometimes start off in the most dangerous manner.

The engineers of the steamship *Baltic* mention a case in which they were sailing apparently upon a smooth sea, and all force was upon the engine, when in a moment the ship seemed to pass a precipice, the wheels instantaneously emerged, and so quick was the start of the engine, that the oil cups upon the cross-heads, as they descended, left their contents suspended in the atmosphere, made a stroke down and up, meeting the oil in its descent, spattering and splashing it in every direction upon the machinery; it is needless to suggest, in such a case, the danger of breaking a shaft or otherwise damaging the machinery.

Loss of a Ship from the want of a Governor.

The U. S. Steamship San Francisco sailed from the port of New York in January, 1854, with government stores, and troops to the number of six hundred souls, and was wrecked, with a loss of about four hundred lives, the disaster occurring entirely from the breaking down of the engines that drove the air pumps and condenser. The following extract from the Journal of the Franklin Institute, will explain the circumstances, volume 27, page 112.

** "But immediately after the vessel gets into the trough of the sea, it is not difficult to imagine that on accunt of the varying depth of water over the injection hole, the quantity of water entering the condenser would vary at different times, 'that the Pump would sometimes be flooded and brought up, and alternately accellerate its velocity until again flooded, &c. There being no adequate means of regulating speed, (for a common Governor would have no effect in such a case,) this sort of action must take place in a greater or less degree.

"Much could be said upon the actual necessity for the safety of a ship upon preventing violent changes in the action of the machinery, but the effect of

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withholding from the engine steam when not wanted, and letting it upon it with consequent unison of power when demanded, is so palpable, that no intelligent mind can fail immediately to see its value; its importance then to underwriters, as well as steamship owners is obvious."

Opinions of Various Authorities on the Merits of Silver's Governor.

"It will be entirely unaffected by any change of position, and perfectly adaptable to marine engines, and its principles render it necessarily a more sensitive regulator for common purposes than the ordinary Governor."

FRANKLIN PEALE.

"As a Governor, it is entirely efficient for all purposes, and under all circumstances." R. F. LOPER.

"Its perfect adaptability to marine engines, cannot be questioned, and the method employed within it, of graduating the resistance to centrifugal force, must overcome the evil effects of the arbitrary laws of gravity that actuate the two ball Governor." PROF. BARNES.

"Many plans have been tried to effect this desirable object, but none have been perfectly satisfactory in their action. . . . . The model works well, and if proper appliances are used to communicate motion to the practical Governor, there is no doubt of its performing equal to the expectation that is entertained of it. . . . . The plan is about to be tested on one of the ocean steamers, (U. S. M. Steamship Atlantic) and if successful, will, most likely, be placed on all of them."

JOURNAL OF THE FRANKLIN INSTITUTE, volume 29, page 416.

"A careful examination of the construction of which will show that its operation must of necessity be sure and perfect under all circumstances."

SCIENTIFIC AMERICAN, volume 12, page 356.

"No steamship should go to sea without one upon her engines."

C. W. COPELAND.

"It has been conceded that Mr. Silver's Governor possesses advantages which no other construction of Governor, heretofore introduced has effected, and performs with uniform efficiency, all that is desirable in a Marine Governor."

THE ARTIZAN.

First Certificate from Officers of the U. S. Naval Steamer, Atlantic.

The first application of this instrument, was upon the U. S. Mail Steamship Atlantic, and although subject to contingencies occasioned by inexperience, after a faithful trial of about six months, which included the extraordinary winter of '55 and '56, received a strong testimonial from Capt. Jas. West, and his Engineers, of which the following is a copy:—

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SILVER'S MARINE ENGINE GOVERNOR.

We, the undersigned, Commander and Officers of the U. S. Mail Steamship Atlantic, having, during our late rough voyages between New York and Liverpool, experienced the practical advantage of Mr. Silver's Marine Governor, hereby take pleasure in testifying to the merits thereof.

As a safeguard to the machinery, and consequently an additional security to a Steamship, we consider the invention an invaluable one, and the objects of the originator effectually accomplished.

JAMES WEST,
CHAS. BERNARD, *Chief Engineer.*
JNO. F. ROBINSON, *Assistant.*
GEORGE R. VANDERBILT, "
C. M. GILL, "
E. VALLET, "
JOHN JONES, "
JOHN BULSON, "

New York, February 29, 1856.

Certificate from the U. S. Mint.

The large engines of the U. S. Mint, at Philadelphia, which drive the rolling mills of that institution, having a momentum wheel of the small diameter, have been found difficult to regulate, but one of the Marine Governors having been applied by order of the Director, Hon. James Ross Snowden, has elicited the following certificate:—

MINT OF THE UNITED STATES,
Philadelphia, June 17, 1856.

I have caused one of Mr. Silver's Marine Governors to be used on the large engines at the Mint. The action is eminently satisfactory. In fact, it controls the motion of the machinery of the rolling and cutting rooms, with a greater regularity than was heretofore attained by the use of the ordinary centrifugal Governor.

JAMES ROSS SNOWDEN,
Director of the U. S. Mint.

Testimony of Proprietors of Public Ledger.

"Much attention had been paid to the regulation of the engine of the Public Ledger newspaper printing office of Philadelphia, by adopting different plans; but of the Marine Governor the proprietors say, 'We have at present one of Silver's Marine Governors upon a stationary engine, which is used for driving the different printing presses in the Ledger Building. The eight cylinder rotary presses require each between four and five horse power to drive them. This power when thrown on or off the engine, produces very sudden changes, and, unless the governor is very sensitive, and acts promptly in supplying or shutting off the steam, would derange the other machinery attached to the engine. Silver's Governor has given perfect satisfaction, and has attained its object better than any other which we have tried.' "

PUBLIC LEDGER, April 12, 1856.

Testimony of New York Tribune.

In speaking of its experience with Silver's Governor, this celebrated Journal says:

"It is now in use on the engine driving our own presses, and regulates considerably quicker, and far more evenly, than did the ball governor before employed, although we consider that an extremely well arranged and healthy specimen."

"We predict for this device a very extensive demand for stationary purposes, and hold that no steamer should attempt to navigate the Atlantic without it."—New York Tribune, Dec. 22, 1856.

Testimony of New York Herald.

In a letter to Messrs. Drexel, Littlefield, Harrison and others, dated New York Herald Office, July 17th, 1857, Mr. J. Elliott, Superintendant, says:

"We have at present, one of Silver's Marine Governors upon a thirty horse engine, which is used to drive the different printing presses in the Herald Building; the ten cylinder rotary presses require each ten horse power to drive them. . . . We have been using this Governor for the last three months, and it has given perfect satisfaction, and has attained its object better than any other plan which we have yet tried."

Second Certificate from the Chief Engineer of the U. S. Mail Steamer Atlantic.

Mr. Thomas Silver,
Queen's Hotel, Liverpool.

Port of Liverpool, Sept. 28th, 1857.

Dear Sir:—In reply to your note of inquiry, relative to the Marine Governor in use on the Engines of the U. S. Mail Steamer "Atlantic," I have the pleasure to state that its action is entirely satisfactory.

We are enabled to make better time in rough weather, as its promptness of action, in regulating the motion of the Engines, secures the greatest development of power at every moment when it is desirable, without endangering the machinery.

In short, it is a guarantee for the proper appropriation of the steam, under all circumstances, and great economy in labor.

Trusting that it meets generally with the high appreciation that it merits, as an improvement to the Marine Engine,

I am, Yours truly,

CHARLES BERNARD,
Chief Engineer.